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OPERATING EXPERIENCE WEEKLY SUMMARY

Office of Nuclear and Facility Safety

April 2 - April 8, 1999

Summary 99-14

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EVENTS

1. EMPLOYEE INJURED DURING DEMOLITION CLEANUP ACTIVITIES

On March 26, 1999, at the Oak Ridge East Tennessee Technology Park, a subcontractor employee was injured when he was struck by a section of chain-link fence being removed by another employee of the same subcontractor operating an excavator equipped with a hydraulic shearing/material-handling attachment. The fence section, which was part of debris being removed following demolition activities, hit the injured employee on the side and back of his head, dislodging his hard hat and safety glasses. Emergency medical personnel administered general first aid to him at the work site for bleeding from neck and head lacerations. The employee was then transported and admitted to a medical facility in Oak Ridge for additional treatment and observation. (ORPS Report ORO--BNFL-K33-1999-0001)

The injured employee has been released from the hospital. Because of the severity of his injuries and the length of his hospitalization, DOE is conducting a Type B Accident Investigation of the event. The investigation will review the subcontractor's work control, work processes, and health and safety procedures. NFS will report the results of the investigation in a future Weekly Summary.

KEYWORDS: accident investigation, decontamination and decommissioning, occupational illness/injuries, occupational safety, stop work, subcontractor

FUNCTIONAL AREAS: Decontamination and Decommissioning, Industrial Safety

2. INADEQUATE LOCKOUT FOR PRESSURE GAGE REPLACEMENT

On April 1, 1999, a maintenance supervisor who was walking down a completed maintenance job at the Savannah River H-Canyon Facility discovered that a mechanic had replaced a pressure gage in the wrong system under an improper lockout and tagout (LO/TO). The mechanic had replaced a gage in a 90-psi instrument air system, but the repair procedure relied on an LO/TO for a steam system. When he realized that the gage was not in the steam system, he verified that air pressure was isolated from the gage and replaced it. When the maintenance supervisor reported the condition, the facility manager immediately stood down all discretionary (non-safety-related) facility operations and initiated an investigation. Although the incident did not result in personal injury or equipment damage, it represents a serious deviation from conduct of operations principles. (ORPS Report SR--WSRC-HCAN-1999-0019)

Liquids are educted from sumps at H-Canyon using steam-driven jet eductors. Pressure gages in the system indicate steam supply pressure to the jet eductors. Similar pressure gages indicate steam and air pressure in a blowdown system used to clear blockages in sump instrumentation dip tubes. Operations personnel discovered that a particular eductor steam jet pressure gage was inoperative, placed a site condition tag on it, and wrote a work request to have it repaired or replaced.

Investigators for this occurrence identified the following sequence of events.

- The operations maintenance coordinator who initiated the associated work package had identified a number for the gage by searching a controlled instrumentation database instead of performing the required field walk-down. His search returned the component identification for an instrument air gage instead of the steam pressure gage. He then wrote a work plan based on this information and indicated that hazardous energy isolation for steam would be required. However, work controllers assigned the work package to an existing LO/TO for the process air system.

- A maintenance lead supervisor who was reviewing work packages to be worked on his shift noticed that the task to replace a steam gage was being controlled under a process air system LO/TO. Because of his understanding of the work, he reassigned the work package to an existing LO/TO for the steam system without walking down the job and without notifying the shift operating manager.

- At the job site, the mechanic assigned to replace the steam gage realized that the gage identified in the work package was in the air system and not in the steam system. He concluded that the work package originator had made a simple mistake and he replaced the air gage, without informing anyone of the discrepancy. As a result, he not only replaced the wrong gage but replaced it without an LO/TO to control the hazard.

According to investigators, facility personnel missed at least three opportunities to avoid this occurrence.

- If the operations maintenance coordinator who initiated the work package had walked down the system, as required by work planning instructions, he would have identified the correct gage and component number.

- If the lead supervisor who changed the lockout assignment had communicated the change to the shift operating manager or had walked down the job, he might have prompted investigation and resolution of the discrepancy.

- The mechanic who replaced the pressure gage did not question the assignment of the work to the steam system lockout, nor did he stop work when a conflict became apparent. If he had stopped work and notified his supervisor when he became aware of an error, he might also have prompted investigation and resolution.

Another recent occurrence at H-Canyon related to LO/TO performance contributed to the facility manager's decision to stand down discretionary operations. On March 10, 1999, a work supervisor who was walking down a lockout prior to signing on to it discovered that a tag for a secondary lockout point had been placed on the wrong component. The primary lockout point, the starter switch for a chilled water pump, was correctly tagged and locked out. However, the installer placed the tag for a secondary lockout point on the wrong pump selector switch and the lockout verifier subsequently verified it as correct. The facility manager suspended work on the lockout and initiated a validation of all lockouts for power support equipment. (ORPS Report SR--WSRC-HCAN-1999-0014)

These occurrences underscore the importance of strict compliance with LO/TO program requirements. A good LO/TO program is an important element of an effective conduct of operations program. LO/TO programs in DOE serve two functions. The first function, defined in both 29 CFR 1910, *Occupational Safety and Health Standards*, and DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities,* is to protect personnel from injury and protect equipment from damage. The second function is to provide overall control of equipment and system status. The standard states that an effective LO/TO program requires three elements: (1) all affected personnel must understand the program, (2) the program must be applied uniformly in every job, and (3) the program must be respected by every worker and supervisor.

The LO/TO program is the primary barrier to employee injury or death. However, it is an administrative program that cannot work properly unless all individuals understand their responsibilities and carry them out with a high degree of discipline. Facility managers should ensure that all managers and supervisors understand their expectations for the LO/TO program and that they effectively communicate and enforce them. These expectations should include attention to detail, verbatim compliance, effective communications, and defense in depth.

KEYWORDS: communication, conduct of operations, lockout and tagout, maintenance

FUNCTIONAL AREAS: Conduct of Operations, Industrial Safety, Mechanical Maintenance

3. NUCLEAR REGULATORY COMMISSION ISSUES NOTICE OF VIOLATION FOR CONTAMINATION EVENT

On April 6, 1999, the Nuclear Regulatory Commission (NRC) Office of Public Affairs issued a press release stating that it has cited Connecticut Yankee Atomic Power Company, operator of the Haddam Neck nuclear power plant, for several violations stemming from a November 2, 1996, radioactivity contamination event. In that event, two workers were contaminated with radioactivity while they were in the reactor cavity and the canal used to transfer nuclear fuel between the reactor and the spent fuel pool. The workers entered the areas to perform inspection and housekeeping activities. However, they also handled, collected, and transported highly contaminated debris, leading to airborne radioactivity and an internal dose of contamination for both of them. A follow-up inspection by NRC staff determined the plant did not have adequate controls in place to ensure the workers were given sufficient instruction on the radiological conditions in the areas and the precautions needed to minimize exposure. Further, NRC found that plant staff had failed to conduct adequate radiological surveys to assess the conditions to which the two were exposed. (NRC Office of Public Affairs No. 99-26)

The NRC is issuing a Severity Level III notice of violation for the infractions. Violations range from Levels I to IV, with Level I being the most severe. Although a fine was considered, the NRC decided to exercise enforcement discretion and not issue one because (1) the violations occurred before the company's December 1996 announcement that it was permanently shutting down the reactor and (2) the company had received a $650,000 civil penalty on May 12, 1997, because of poor performance before the shutdown decision.

In addition, NRC decided to exercise discretion and refrain from issuing a notice of violation to the utility for a series of issues identified during a review of the plant's operating history. Following revelations that radioactively contaminated materials had been released from the plant site over the years, NRC in March 1998 prepared a report on the facility's almost 30-year operating history. The report identified several violations, including inadequate surveys following plant operation with leaking fuel rods; an inadequate procedure for the release, for unrestricted use, of materials from the plant's radiation controlled areas; and insufficient record keeping. NRC determined enforcement action was not necessary in this case because the company had already initiated corrective actions for these issues, including extensive off-site surveys and remediation of the areas. In addition, the broad programmatic corrective actions as a result of the 1996 airborne contamination event and the 1998 decontamination events sufficiently address NRC's concerns. Also, a Level IV violation related to reactor coolant system decontamination work in 1998 is being treated as a non-cited violation, in accordance with NRC enforcement policy.

NFS reported the November 1996 radioactivity contamination event in Weekly Summary 97-27 after NRC issued an Information Letter on it. In that event, two workers scraped up highly radioactive debris and placed it in a plastic bag while performing a cleanliness inspection of the fuel transfer canal. Health physics technicians (HPT) surveyed the bag of debris and recorded 60 rem/hr on contact and 4 rem/hr at 30 cm. Nasal smears from the workers indicated 200,000 dpm beta/gamma. The HPTs determined that none of the workers' doses exceeded limits; maximum assigned doses are 473 mrem deep dose and shallow dose equivalent, 1,164 mrem extremity, and 397 mrem eye lens dose equivalent. Air samples indicated airborne radioactivity concentrations of 3.5 DAC beta and 108 DAC alpha. The maximum committed effective dose equivalent was 913 mrem, with a total organ dose equivalent to the bone surface of 5,873 mrem. Poor radiological work controls contributed to these unplanned exposures. (NRC Information Notice 97-36)

NRC inspectors determined that the pre-work briefing was inadequate because there was no common understanding between the workers and the HPTs as to what work was to be done. They also identified the following deficiencies.

- The work procedure provided no work scope detail.
- HPTs did not know that the workers would hand-collect paint chips, metal rust, and dried, dirt-like materials from the floors and walls.
- The workers did not know the actual radiological conditions in the canal.
- HPTs led the workers to believe the canal was generally clean following decontamination in August 1996.

The NRC inspectors also determined the HPTs did not perform pre-work contamination or radiation surveys to support the job. Surveys performed after the work was completed indicated up to 80 mrad/hr beta/gamma and 30,000 dpm/100 cm^2 alpha removable contamination in the canal. A local hot spot on the canal floor indicated 25 rem/hr on contact and 8 rem/hr at waist level. Inspectors also determined the workers were allowed to begin work with an invalid radiation work permit instead of one specifically written for the fuel transfer canal work. Based on air sample results from the August 1996 decontamination, which did not reflect the extensive debris cleanup, the HPTs decided not to require the use of respiratory protection. Backup air sampling of the reactor cavity was well away from the fuel transfer canal and therefore was not representative of the air in the canal. An HPT checked the air sample filters with a handheld survey instrument. However, the instrument was inoperative, so it indicated no airborne radioactivity. Believing there was no airborne radioactivity, HPTs authorized two other workers to enter the reactor cavity. The workers unknowingly spent 15 minutes in an area with elevated levels of airborne contamination.

Connecticut Yankee initiated the following corrective actions based on a root cause analysis and the findings of an independent review team.

- It suspended all work in radiological areas of high risk until it had instituted a work-approval program that required the plant radiation manager and work services director to review and approve all radiation work permits.
- It implemented a radiation work permit procedure that required clear descriptions of authorized work controls, improved procedures for high-risk evolutions, and representative pre-work surveys.
- It stopped the use of in-field counting and checks for air samples as a basis for reducing or relaxing radiological work controls.
- It required workers to use respirators for work in areas where there was a high risk of alpha intake until air sampling justified working without them.

KEYWORDS: contamination, internal exposure, radiation protection, work planning

FUNCTIONAL AREAS: Licensing/Compliance, Radiation Protection, Work Planning

4. OXYGEN DEFICIENCY DISCOVERED AT NITROGEN FILL STATION

On March 24, 1999, at the Pacific Northwest National Laboratory (PNNL), an industrial hygienist discovered that oxygen levels at a liquid nitrogen filling station were below the minimum standard of 19.5 percent. Only 18.4 percent oxygen was found while an operator was filling 4-liter dewars (vacuum bottles) with liquid nitrogen. Building managers curtailed all nitrogen filling operations pending investigation. After attending a Research and Development staff safety meeting at which a lessons-learned video on the CO_2 release at Idaho National Engineering and Environmental Laboratory was viewed, building occupants had requested that the fill station area be monitored for possible oxygen depletion. In the Idaho release, an oxygen deficiency caused a fatality and life-threatening injuries. (ORPS Report RL--PNNL-PNNLBOPER-1999-0006)

Following the viewing of the lessons-learned videotape on the CO_2 release at Idaho, building personnel held a discussion. One person mentioned that the nitrogen fill station might behave in a similar way, depleting oxygen in a confined area. The liquid nitrogen fill station is located in a 15- by 20-ft room that has only a ventilation supply. Operators would typically keep a door open to ensure that a ventilation path existed while they filled up to three dewars at a time continuously for about one hour. The 4-liter dewars were used to replenish several 30-liter dewars to cool instruments in an adjacent room. Although no one had ever reported experiencing the physiological effects of oxygen deficiency, personnel asked to have the area monitored.

The building manager conducted a critique of the finding on March 25. Critique members determined that although a procedure did exist for the filling of 4-liter dewars in the building, no consideration had been given to oxygen displacement. They determined that until engineered controls and safety evaluations are completed, all use of the liquid nitrogen fill station will require the presence of an industrial hygienist to monitor the oxygen content of the work area. A large fan will be used at one of the room doors to the outside to help remove any gas. If the oxygen content falls below 19.5 percent, filling activities will cease until the level returns to normal (20.9 percent). To ensure that these measures are taken, the building manager directed the fill station to be kept under lock and tag to prevent its inadvertent use. Since this discovery, management has checked each PNNL nitrogen fill station (all PNNL facilities) to determine if other oxygen-deficient conditions exist. Long-term corrective actions include installation of a permanent fan in the door to the outside, revised operating procedures, and installation of an oxygen monitor.

The minimum legal oxygen requirement is 19.5 percent and the oxygen content of normal air at sea level is 20.9 percent. Depleted oxygen conditions can occur in confined or unventilated cellars, wells, mines, ship holds, tanks, burning buildings, and enclosures containing inert atmospheres. Table 4-1 shows atmospheric oxygen levels (percent by volume) and the corresponding physiological effects.

TABLE 4-1. OXYGEN CONTENT VERSUS PHYSIOLOGICAL EFFECTS

OXYGEN (vol.-%)	PHYSIOLOGICAL EFFECTS
16% to 12%	Loss of peripheral vision, increased breathing volume, accelerated heartbeat, impaired attention and thinking, impaired coordination.
12% to 10%	Very faulty judgment, very poor muscular condition; muscular exertion causes fatigue that may cause permanent heart damage, intermittent respiration.
10% to 6%	Nausea, vomiting, inability to perform vigorous movement, unconsciousness followed by death.
Less than 6%	Spasmatic breathing, convulsive movements, death in minutes.

This event illustrates the effectiveness of sharing lessons learned at other facilities and sites throughout the DOE complex. A previously unknown condition that was a potential safety hazard was identified because PNNL personnel had a questioning attitude after discussing lessons learned from a serious event. Although the room that contained the nitrogen filling station was not considered to be a confined space, inadequate ventilation, filling rates, and the rate of nitrogen vaporization could produce an oxygen-deficient condition. The hazards associated with asphyxiants or gases that can displace oxygen need to be thoroughly evaluated, and measures need to be in place to ensure personnel safety.

NFS encourages managers to incorporate lessons learned from other organizations and to take these lessons into account in their programs. Lessons learned are valuable only if the information that is shared is used. DOE-STD-7501-95, *Development of DOE Lessons Learned Programs*, was designed to promote consistency and compatibility across programs. Both lessons learned and program managers should review the standard and incorporate applicable elements into their site programs. Managers, supervisors, and operators should review lessons-learned documents for applicability, and the information should be used to improve operations.

KEYWORDS: atmosphere, industrial hygiene, nitrogen, oxygen

FUNCTIONAL AREAS: Industrial Safety, Lessons Learned, Operating Experience

5. BROKEN VENT TUBING CAUSES CHLORINE TO LEAK

On March 25, 1999, at the Hanford Site, chlorine began to leak while operators were pressurizing a facility chlorine system at the 283 East Water Plant. The chlorine gas escaped through a broken pressure relief vent line (Tygon® tubing) into the chlorine injector room. A chlorine detector in the injector room alarmed and personnel were evacuated. The vent line normally discharges to the outside of the facility. Facility operators had not identified the broken vent line during their facility inspections and no preventive maintenance had been performed on the chlorine system. There were no personnel injuries as a result of this event, but seven people went to first aid to be evaluated for possible exposure to chlorine. All personnel were evaluated and returned to work. Chlorine gas is hazardous because it can burn human tissue and cause asphyxiation. (ORPS Report RL--PHMC-S&W-1999-0002)

HAZMAT team and emergency response personnel isolated the leak and surveyed the area and the facility for chlorine gas. They reported no evidence of residual chlorine at the site, indicating there was no continued release to the environment. Chlorine has a characteristic sharp, penetrating odor above 3 to 5 ppm, and at higher concentrations its effects are so painful and severe that it is unlikely anyone would remain in the area. Low concentrations irritate mucous membranes, the respiratory system, and the skin. Chlorine is heavier than air and attacks many metals, plastics, rubber, and coatings.

Investigators determined the direct cause of the event to be an equipment/material problem, namely, an end-of-life failure of the chlorine injector pressure relief vent tubing, which becomes brittle from exposure to chlorine. No requirements had been set for the intervals at which the Tygon® tubing was to be replaced. The manufacturer recommends performing preventive maintenance yearly and replacing tubing at that same interval. A contributing cause was personnel error, in that operations personnel failed to identify the broken vent tubing during facility inspections or surveillances. Investigators also determined that the emergency response team was not totally familiar with the facility systems. Plant operators had to tell them how to isolate chlorine cylinders and how to reset alarms in order to determine if they were still detecting chlorine. Corrective actions included (1) replacing the broken Tygon® tubing, (2) scheduling inspection and replacement of remaining Tygon® tubing on all chlorine injectors at the 283 East and 283 West Water Plants, (3) developing a preventive maintenance recall for the replacement of chlorine injector component parts, and (4) providing facility orientation training for the emergency response team members.

Corrosive gases such as chlorine may expedite the deterioration and failure of gas cylinder systems and components. Maintenance personnel should be aware of the properties of such gases and develop inspection programs for cylinder systems and components that contain them. NFS issued DOE/EH-0527, Safety Notice 96-03, *Compressed Gas Cylinder Safety*, which describes events at DOE facilities involving compressed gases and their effects. Safety Notice 96-03 can be obtained by contacting the Information Center, (301) 903-0449, or by writing to ES&H Information Center, U.S. Department of Energy, ES&H Information Center, EH-72, 19901 Germantown Road, Germantown, MD 20874. Safety Notices are also available on the OEAF home page: http://tis.eh.doe.gov:80/web/oeaf/lessons_learned/ons/ons.html.

This event is similar to a January 26, 1997, event in which a chlorine gas leak caused a building at the Lawrence Livermore National Laboratory to be evacuated. A pressure relief valve connected to a chlorine gas manifold failed, allowing chlorine to escape. The chlorine detection system automatically isolated the leak and activated the building evacuation alarm. No one was injured as a result of the event. Investigators determined that the facility practice of purging the chlorine gas lines with nitrogen at pressures greater than the chlorine pressure accelerated the failure of the relief valve because it produced additional stresses in the corrosive chlorine environment. (OEWS 97-13 and ORPS REPORT SAN--LLNL-LLNL-1997-0004)

NFS has reported other events in the Weekly Summary that resulted from inadequate preventive maintenance. Some examples follow.

- Weekly Summary 99-12 reported that a battery exploded at the Idaho National Engineering Environmental Laboratory while a utility operator was starting a diesel-driven fire pump. One quart of acid spilled on the concrete floor when the battery exploded. Investigators determined that no one had performed any preventive maintenance inspection on or surveillance of the batteries since September 1997. (ORPS Report ID--LITC-CFA-1999-0003)

- Weekly Summary 99-02 reported that a cable fault in an underground conduit at the Brookhaven National Synchrotron Light Source Facility caused a fire that spread to other conduits, severely damaging 15 480-V, 1,600-amp cables. A circuit breaker feeding one of the damaged cables failed to trip. If the breaker had operated properly, the damage sustained by the conduits would have been limited. Investigators determined that a less-than-adequate preventive maintenance program was the root cause. The lack of a standard preventive maintenance schedule for 480-V breakers allowed a breaker malfunction to remain undetected. (ORPS Report CH-BH-BNL-NSLS-1997-0005)

These events illustrate the importance of ensuring that equipment and systems are included in preventive maintenance programs. Personnel who track and schedule surveillances, inspections, and preventive maintenance should ensure that these activities are properly scheduled. Also, it is important that manufacturers' recommendations for inspection and replacement frequencies are heeded. The events also underscore the importance of being aware of the problems associated with aging equipment and of service life limitations. Although it is often impossible to predict the failure of a particular component, the following references provide some useful guidance for facility managers on the maintenance of aging equipment.

- DOE-STD-1073-93, *Guide for Operational Configuration Management Program,* discusses the importance of conducting aging-degradation evaluations and determining the present condition of components.

- DOE 4330.4B, *Maintenance Management Program,* discusses establishing programs for the management and performance of effective maintenance and repair. Section 5.2 of the Order addresses planned preventive maintenance to ensure that equipment operates within the designed operating conditions. The Order includes guidance for incorporating vendor recommendations for predicting component degradation so as to allow for replacement before failure.

KEYWORDS: compressed gas, inspection, preventive maintenance, tubing

FUNCTIONAL AREAS: Industrial Safety, Mechanical Maintenance

6. INADEQUATE CONTROL OF BASIS FOR INTERIM OPERATION

On March 19, 1999, at the Savannah River F-Canyon Area, engineers performing a field verification of controls to prevent mixing of 40 percent ferrous sulfamate (FS) and 64 percent nitric acid discovered an orifice plate had been installed instead of the blank flange required by the basis for interim operation (BIO). The orifice plate is in an FS inlet line to a process head tank. The F-Canyon BIO requires physical control of piping configurations to prevent mixing of potentially incompatible chemicals in areas accessible to personnel. Mixing of these chemicals generates large quantities of nitrous oxide gas, which could overwhelm the tank exhaust system and escape to an area that is occasionally occupied. (ORPS Report SR--WSRC-FCAN-1999-0008)

Facility personnel conducted the field verification as a proactive response to a similar discovery at the H-Canyon Area. In that occurrence, engineers discovered that two blank flanges required by the authorization basis for two box decanters had not been installed. Investigators believe that during a verification of BIO controls for an earlier phase of system startup, facility personnel had mistakenly identified blanks in adjacent wall nozzles as those required by the BIO. The authorization basis was not violated because other process controls provided defense in depth. (ORPS Report SR--WSRC-HCAN-1999-0013)

Investigators for the discovery at the F-Canyon Area determined that personnel who had conducted an initial verification of BIO controls in 1994 relied on system drawings that did not show piping that was installed in 1989. To support operating procedure sketch upgrades in 1995, facility procedure writers had produced a one-line diagram of the affected system that did show the piping, but they mistakenly identified the orifice plate as a blank flange. Engineers discovered the error when they conducted a closer examination of the piping configuration as part of their field verification.

The F-Canyon Area no longer uses 40 percent FS in its processes. To restore defense in depth, the F-Canyon Shift Operating Manager immediately authorized administrative locks on a normally closed valve upstream of the orifice and on the discharge valve for a pump capable of transferring FS to the F-Canyon Area. As a followup action, facility personnel have physically disconnected the FS inlet line to the tank.

These occurrences underscore the need to establish and maintain positive control of the BIO for existing facilities. The BIO is part of the overall management plan required by DOE Order 5480.23, *Nuclear Safety Analysis Reports*, to upgrade an existing facility's safety analysis. It describes the operating restrictions, administrative controls, and safety assurance features that the M&O contractor proposes to implement during the safety analysis upgrade process. It is intended to provide a satisfactory basis for DOE authorization for continued operation during this interim period. Design basis documentation for existing facilities may not reflect changes made to systems before the onset of contemporary configuration control discipline. Facility managers should ensure that the descriptions of facility design and configuration contained in the facility BIO are based to the greatest practical extent on field verifications. They should also ensure that the facility's surveillance test program includes surveillance for BIO requirements that can easily be altered as a routine facility activity.

KEYWORDS: authorization basis, basis for interim operation, configuration control

FUNCTIONAL AREAS: Configuration Control, Licensing/Compliance

7. FIRE PROTECTION VALVE FAILURES AND TESTING DEFICIENCIES

On March 22, 1999, the Nuclear Regulatory Commission (NRC) issued Information Notice 99-07, *Failed Fire Protection Deluge Valves and Potential Testing Deficiencies in Preaction Sprinkler Systems*. The notice describes the failure of fire protection systems to perform their design functions at a commercial nuclear power plant. These failures resulted from poorly designed sprinkler system automatic control valves and associated solenoid valves, deficient maintenance, and inadequate valve testing. Since 1996, an NRC commercial nuclear power plant licensee has experienced failures of the Grinnell Model A-4 Multimatic valves. Although the licensee's root cause investigation team was unable to determine the root cause of the valve failures, NRC staff identified several potential problems. (NRC Information Notice 99-07)

In March 1996, during surveillance testing of preaction sprinkler systems, the licensee found that 5 of 11 Grinnell Model A-4 valves failed to open when water pressure was vented from the diaphragm chamber. The licensee continued testing and identified more sprinkler system automatic control valves that also failed. A root cause team determined that the valve diaphragm was sticking to its retainer and push rod disk, the push rod showed wear, and the solenoid valves did not bleed water pressure from the diaphragm area, as designed. The team believes that abrasive cleaning of valve push rods and push rod guides inside the diaphragm retainers caused rust to form, which in turn caused the solenoid valve plunger assemblies to stick. Root cause team members also determined that actual fire protection system operating pressures exceeded solenoid valve design pressures and that the higher pressure may have prevented the valves from opening.

In February 1998, the licensee discovered during surveillance testing that a preaction sprinkler system valve had failed to trip open. The valve had been left in a tripped condition for approximately 9 months. The licensee sampled six more valves that had also been in a tripped condition for long periods. They found that five of the six valves, as well as the original valve, had failed. In June 1998, as it was conducting another testing program, the licensee discovered a deluge valve that failed to open when manually actuated but that successfully operated after adjustments were made to its pull station housing.

NRC staff identified the following potential problems as a result of these failures.

- Valves that are left in a tripped condition for long periods and then reset may experience bonding of the valve diaphragms to the push rod flanges, preventing proper valve operation.
- Plant-supplied or -designed preaction valve connections (for monitoring diaphragm chamber and main water supply pressures and for providing valve drainage and diaphragm chamber supply water) can result in undersized drains that restrict diaphragm chamber bleed-off and prevent valve actuation.
- High fire protection water supply system pressures may cause valve release mechanisms to jam because of valve latch indentations. Internal valve component cleaning and inspections should identify these problems.

NRC staff members also believe that valve actuation problems can be masked during full-flow testing if the deluge valves are isolated from the fire protection water supply and the diaphragm is bonded to the flange. This could allow partial blockage of the diaphragm chamber and inhibit valve actuation, even as the valve passes testing. However, if the deluge valves are not isolated from the water supply and the diaphragm is bonded to the flange, the valve would not actuate because of trapped water in the diaphragm chamber, allowing the bonding problem to be identified.

NFS has reported events in which fire protection systems failed in several Weekly Summaries. Some examples follow.

- Weekly Summary 99-02 reported that fire protection engineers at the Argonne National Laboratory East determined that 11 of 12 sprinkler heads failed to operate when tested. The sprinkler heads failed to operate because of an inadequate O-ring seal. This caused a buildup of corrosion products on the exterior of the sprinkler that would render the valves inoperative during a fire or related event. All of the sprinklers exhibited signs of external corrosion. All of the failed sprinkler heads were Reliable Model "A" flush pendant sprinklers. (ORPS Report CH-AA-ANLE-ANLEESH-1998-0001)

- Weekly Summaries 98-41, 98-12, and 97-49 reported other problems with malfunctioning sprinklers. These problems involved Omega fire sprinklers manufactured by Central Sprinkler. The Omegas feature O-rings in their design. The Consumer Products Safety Commission required the manufacturer to recall the sprinklers.

The NRC information notice illustrates the need for personnel to ensure that fire protection system testing methods are adequate to demonstrate system operability. When fire protections systems fail surveillance requirements or are not maintained operational, appropriate compensatory measures must be taken. Facility managers should ensure that fire protection systems are installed, inspected, and maintained using National Fire Protection Association (NFPA) standards.

- DOE O 420.1, *Facility Safety*, section 4.2.2, "Fire Protection Design Requirements," specifies requirements for automatic fire-extinguishing systems and establishes requirements to develop, implement, and maintain comprehensive fire protection programs.

- NFPA 13*, Installation of Sprinkler Systems*, governs the design and installation criteria for installing sprinkler systems.

- NFPA 25, *Inspection, Testing, and Maintenance of Water-based Fire Protection Systems*, describes acceptance testing and periodic testing and maintenance requirements. It states that deluge or preaction valves shall be trip-tested annually at full flow in warm weather and in accordance with the manufacturer's instructions.

- DOE Safety Alert DOE/EH-0518, January 1999, *Potentially Defective Automatic Fire Sprinklers*, addresses recent DOE sprinkler problems. This safety alert is available at http://tis.eh.doe.gov/docs/hha/hha_99_1.html. It recommends replacement and operability testing of all Omega sprinklers and of a sampling of Reliable Model "A" sprinklers.

Results of DOE fire safety community activities are frequently shared on the fire protection listserver, which is accessible from the DOE Fire Protection home page, located at http://tis.eh.doe.gov/fire/. NRC information notices can be found at http://www.nrc.gov/NRC/reference.html. Ordering information for NFPA documents may be found at http://www.nfpa.org. Omega sprinkler recall information can be obtained at http://www.cpsc.gov/cspcpub/prerel/prhtml99/99008.html.

KEYWORDS: corrosion, fire suppression, inspection, sprinkler

FUNCTIONAL AREAS: Fire Protection, Licensing/Compliance